

1100 Seventeenth Street, N.W. Washington, D. C. 20036

FROM: R. D. Raymond

BELLCOMM, INC.

1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: A Semi-automatic Procedure for
Controlling CM Cabin Atmosphere
Enrichment - Case 320

DATE: February 21, 1968

FROM: R. D. Raymond

MEMORANDUM FOR FILE

INTRODUCTION

Although the conflict between using a high or low concentration of oxygen in the CM cabin, desirable for physiological and flammability reasons respectively, is effectively resolved for the period before hatch closure on the pad (air at sea level pressure) and after achieving the nominal flight condition (pure oxygen at 5 psia), the transition procedures are not yet clearly defined. The following procedure is suggested as a satisfactory and equitable means of transition between these two steady state conditions.

PROCEDURE

The procedure starts at CM hatch closure on the pad, with ambient air in the cabin. A ten-minute leak check is performed about one hour before launch using oxygen to raise cabin pressure 5 psi above ambient. After the leak check the cabin pressure is reduced to a small positive differential (1/4 psi) with respect to ambient. Then essentially a steady state exists until liftoff. This prelaunch procedure enables an accurate leak check, as described in a memorandum by L. G. Miller.* At launch the cabin atmosphere is approximately 41% O₂/59% N₂ at 14.7 psia as a result of the cabin leak check and subsequent vent.

During ascent, after about T + 4 minutes, the cabin pressure relief valve is manually opened for about 15 seconds to quickly reduce the cabin pressure to 3.5 psia (as read on the cabin pressure gage). Then in the next 2.5 to 3 minutes, the cabin pressure automatically returns to 4.6 psia by means of the cabin emergency pressure regulator. This vent and repressurize cycle is repeated two more times at about three minute intervals, as rapidly as the cycle can be performed. The three simple manual operations and pressure readings are completed by orbit insertion at about T + 11 minutes. At approximately T + 13 minutes the final automatic repressurization cycle has increased the cabin atmosphere to about 73% O₂/27% N₂ at 4.6 psia. The pressure con-

*Miller, L.G. On-Pad Command Module Leak Check for Block II
Spacecraft, Memorandum for File, dated February 6, 1968

tinues to be automatically increased by the cabin pressure regulator to a minimum of 4.8 psia by T + 30 minutes, resulting in about 74% O₂.

The oxygen concentration will continue to increase as the nitrogen-oxygen mixture that slowly leaks from the cabin is replaced by pure oxygen. Very little change will occur prior to transposition and docking. However, during tunnel pressurization after docking, a pound or two of oxygen will be added, raising the oxygen concentration to nearly 80%. After this operation the nitrogen will continue to leak from the cabin at a slow rate that will result in about 95% O₂/5% N₂ by the time of lunar orbit insertion. The pressure profile through tunnel pressurization is illustrated in Figure 1.

During the above procedures the direct O₂ metering valve is opened slightly to maintain a positive suit pressure. This manual control is turned on at crew entry on the pad and turned off at any convenient time after cabin pressure venting.

OBSERVATIONS

The following observations are listed in support of the suggested procedure:

1. The cabin oxygen concentration is low (21-41%) during pad operations, including leak check.
2. The cabin atmosphere is essentially at sea level equivalent at orbit insertion.
3. No additional crew operations are introduced in the post-insertion timeline.
4. More than 2 of the 6.7 pounds capacity of gaseous oxygen remain in storage at orbit insertion. The repressurization cycles require a total of only 5.4 pounds and the cryogenic resupply flow rate replaces about 0.8 pounds of gaseous oxygen. The gaseous oxygen tanks are automatically refilled before the end of the first orbit, based on a resupply rate of 8 to 9 pounds per hour.
5. The operations required during ascent are simple manipulations of the relief valve and visual readings of the cabin pressure gage in a one or two g environment.
6. The procedure is compatible with existing hardware.

R D Raymond

R. D. Raymond

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Attachment
Figure 1

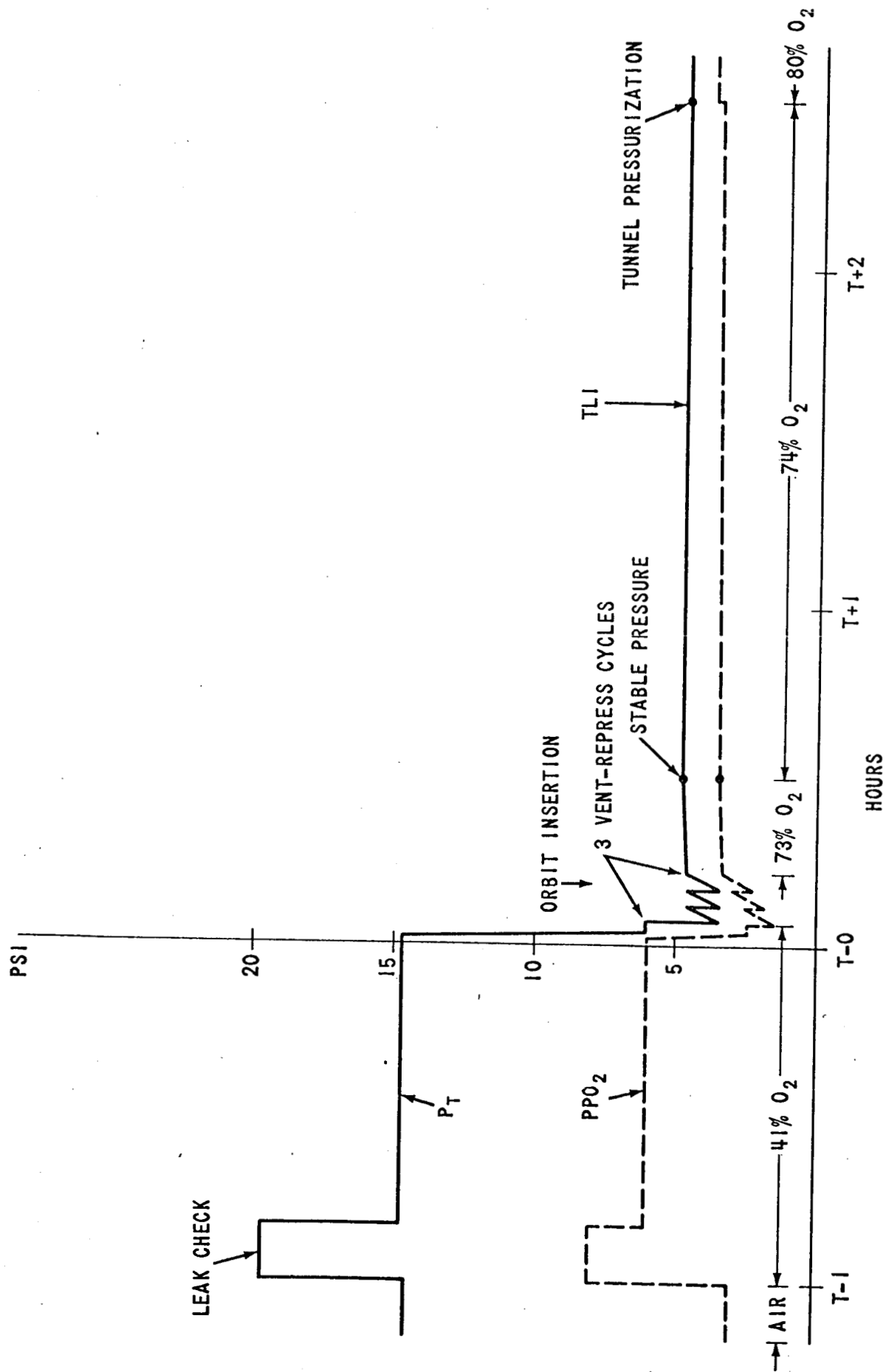


FIGURE 1 - PRESSURE PROFILE